



Fernando, WAC., Canagarajah, CN., & Bull, D. (2000). *Fade, dissolve and wipe production in MPEG-2 compressed video*. 322 - 323.
<https://doi.org/10.1109/ICCE.2000.854658>

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FADE, DISSOLVE AND WIPE PRODUCTION IN MPEG-2 COMPRESSED VIDEO

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ABSTRACT

With the increase of digital technology in video production, several types of complex video special effects editing have begun to appear in video clips. In this paper, a novel algorithm is proposed for fade-in, fade-out, dissolve and wipe video editing operations in MPEG-2 [1] compressed domain without full frame decompression and motion re-estimation. Results show that both objective and subjective quality of the edited video in compressed domain closely follows the quality of the edited video in uncompressed video at the same bit rate.

1. INTRODUCTION

Due to the increase in video products such as digital cameras, camcorders and storage devices (DVDs), digital video editing is becoming increasingly popular. Several commercial desktop video editors are available today and with the increased availability of low-cost video capture devices such editors are gaining market share day by day. Video special effects are needed to enhance the quality of video production. However, most of these video editing tools are designed for spatial domain processing. The large channel bandwidth and memory requirements for the transmission and storage of image and video necessitate the use of video compression techniques [1]. Hence, the visual data is expected to be stored mostly in the compressed form. While compression allows efficient transmission and storage, editing a video clip in compressed domain representation has been problematic. Therefore, most common desktop video editing systems first convert the compressed domain representation to a spatial domain representation in order to perform the editing function (Figure 1). This increases the overall computational complexity of the editing process. In order to avoid the unnecessary decompression operations and compression processes, it is efficient to edit the image and video in the compressed format itself. Smith et al [2] showed how the algebraic operation of pixel-wise scalar addition and multiplication can be done in DCT compressed domain. However, problems are encountered in extending this scheme for video compression standards such as MPEG-2. Shen proposed DC-only fade-out operation for MPEG compressed video [3]. This algorithm [3] is proposed under the crude assumption that fade-out is viewed as a reduction of picture brightness.

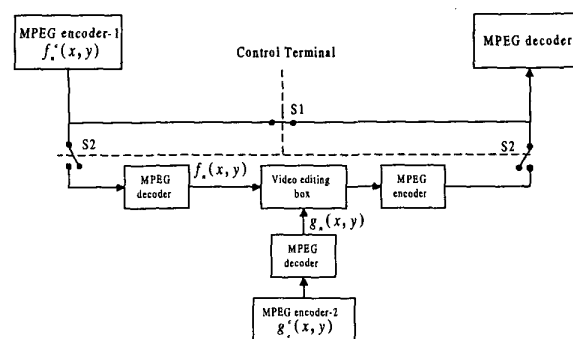


Figure 1: Conventional compressed domain video editor (f_n^c – Compressed signal of f_n and g_n^c – Compressed signal of g_n)

In this paper we present a novel technique for fade-in, fade-out, dissolve and wipe editing operations in MPEG-2 compressed video without full frame decompression and motion re-estimation.

2. PROPOSED SCHEME

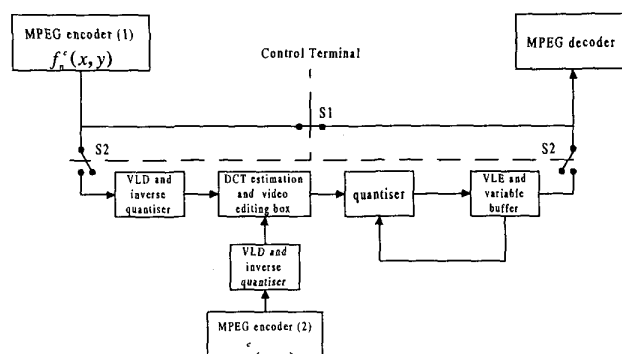


Figure 2: Proposed compressed domain video editor

Figure 2 shows the proposed compressed domain video editor. Two MPEG compressed video streams are applied to the editor and these two streams are partially decoded with variable length decoder (VLD) and the inverse quantiser. With this data, Discrete Cosine Transform (DCT) coefficients can be estimated for each frame [4]. Then these DCT coefficients and motion vectors are applied to the video editing box to process the special effects. Finally, all MBs are quantised to suit the channel bit rate. The quantisation is achieved through the feedback loop from the buffer as in normal MPEG-2 video encoding.

2.1 Fading/Dissolving

DCT coefficients for every frame are extracted and fading operation are applied to each MB separately in DCT domain. Since fade operations are not done with sequences, with large motions, it can be assumed that existing motion vectors are good approximations for the fade sequence. Therefore, these motion vectors are used and corresponding DFD signals are modified accordingly. Thus, the DFD signals are re-calculated with the existing motion vectors and all MBs are coded as before, unless DFD signal is too large. If the DFD signal is too large then this particular MB needs to be intra-coded. Motion vectors are highly optimised when the fade length is large. Therefore, new DFD signal is comparatively large with respect to the old DFD signal for a small fade length. However, new DFD signal reaches to its old DFD signal when fade length increases. Therefore in general, if inter-coded frames are used continuously, picture quality may be degraded (especially high frequency components) as same quantisation matrices are used to quantise new DFD signals. To avoid this situation, intra-coded frames are used periodically to maintain the required picture quality. Therefore, in this proposed scheme existing motion vectors are used for all B-frames and all MBs in P-frames are intra-coded. The same algorithm can also be applied for dissolving as well. However, for dissolved sequence there are two sets of motion vectors from encoder-1 and encoder-2. Thus, two new DFD signals have to be evaluated with two sets of motion vectors and the lowest DFD signal should give the best motion vector for a particular MB.

2.2 Wiping

During a wipe transition changes are occur along the transition boundary. Therefore, existing motion vectors can be used very effectively for all MBs other than MBs on and close to the transition boundary. Thus for wipe editing, all MBs on the transition region are intra coded and all other MBs are motion compensated using the existing motion vectors.

We also made allowances for various end points in the MPEG sequence (i.e. I, P or B frames).

3. RESULTS

Results show that the average PSNR of the proposed scheme closely follows the average PSNR of the conventional scheme. The small drop in PSNR of the proposed scheme is acceptable when we consider the significant savings in computational complexity. Furthermore, we observed that the subjective quality of the edited video with the proposed scheme is very similar to the conventional method. Figure 3 presents the subjective quality comparison for a frame in fade-in editing process. We tested this proposed scheme for fade-in, fade-out, dissolve and wiping patterns with different rates and different MPEG-2 video bit streams and observed similar set of results. Some of these results are summarised in Table (1).

Description	Number of Frames	Average PSNR (dB)	
		Conventional	Proposed
Forward Vertical Wiping	10	41.0	40.2
Forward Horizontal Wiping	10	45.8	45.2
Forward Horizontal Wiping	12	40.1	39.6
Forward Barn-doors Wiping	15	48.4	47.7
Backward Barn-doors Wiping	20	37.6	37.1
Forward Horizontal Wiping	20	47.8	47.4
Backward Vertical Wiping	30	47.4	46.8
Dissolve	30	37.6	36.5
Dissolve	50	41.0	40.1
Dissolve	60	41.7	40.9
Fade-out	40	47.1	46.4
Fade-out	50	47.2	46.6
Fade-in	20	48.2	47.3
Fade-in	30	48.3	47.5
Fade-in	50	45.4	44.9

Table 1: Summarised results (12,3 GOP structure)

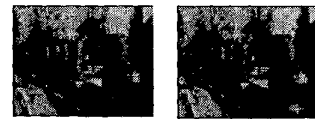


Figure 3: Subjective quality comparison for fade-in operation (from left, conventional and proposed)

4. CONCLUSIONS

In this paper, a novel algorithm is proposed for fade-out, fade-in, dissolve and wipe video editing operations in MPEG-2 compressed domain without full frame decompression and motion re-estimation. We estimated DCT coefficients for all frames and used these DCT coefficients together with the existing motion vectors to produce these special effects in compressed domain. Results show that the subjective and objective quality of the edited video closely follows the quality of the edited video with the conventional method. By providing a compressed domain solution, this proposed scheme offers a much faster operations compared to the conventional scheme. Unlike the conventional scheme, proposed scheme is computationally inexpensive and makes real time implementations feasible. Future work is required to extend this work for complex video special effects.

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